readily in air when hot than when cold. The difference between a positive and a negative charge is also more strongly marked at high temperatures, the negative charge being more rapidly dissipated.—Point discharge potentials in air and hydrogen, by K. Wesendonck. The quantity of negative electricity discharged into hydrogen is greater than the quantity of positive electricity discharged at the same potential, but the initial discharge potentials are not necessarily different.—The atomic theory in natural science, by L. Boltzmann. The conception of the atom cannot be finally superseded by the differential equation as applied to a *continuum*, since the latter is itself based ultimately upon the conception of a discrete structure, even in such applications as Fourier's theory of thermal conductivity. The atom has also the advantage of greater immediate clearness and picturesqueness over the differential equation, whether it really exists or not.—On discharge rays, and their relation to kathode and Röntgen rays, by M. W. Hoffmann. Discharge rays are contained in the spark discharge in air, hydrogen, and nitrogen at ordinary or low pressures. They exert no photographic action, but may be discovered by their property of imparting luminescence to solid solutions of manganese sulphate in gypsum when heated to a temperature below incandescence (thermo-luminescence). They are intercepted by mica, quartz, fluorspar, and other solids, unless produced at low pressures. They proceed in straight lines, and are not deflected by a magnet. They differ from ultra-violet light in their power of penetrating air, and not fluorspar. They are not reflected by solids.—Platinised electrodes and determinations of resistance, by F. Kohlrausch. The solution used by Lummer and Kurlbaum for making bolometers, viz. one part platinum chloride, to 0·008 lead acetate and 30 water, gives a platinum black, which is very useful for platinising electrodes. It facilitates the use of smaller electrodes for alternate-current resistance measurements, and gives a well-marked minimum of telephone effect.—Electric moment of tourmaline, by W. Voigt. This was determined by breaking the tourmaline into fragments, and was found to be 33·4 C.G.S. units.—A new formula for spectrum waves, by J. J. Balmer. The author substitutes for the infinite geometrical progression in Kayser and Runge's formula a closed term, and gives the frequencies for the lines of each series in the form $A - B/(n+c)^2$.

SOCIETIES AND ACADEMIES.

London.

Royal Society, January 21.—"On Reciprocal Innervation of Antagonistic Muscles." Third Note. By C. S. Sherrington, F.R.S., Holt Professor of Physiology, University College, Liverpool. Received December 29, 1896.

If transection of the neural axis be carried out at the level of the crura cerebri in, *e.g.* the cat, there ensues after a somewhat variable interval of time a tonic rigidity in certain groups of skeletal muscles, especially in those of the dorsal aspect of the neck and tail and of the extensor surfaces of the limbs. The details of this condition, although of some interest, it is unnecessary to describe here and now, except in so far as the extensors of the elbow and the knee are concerned. These latter affect the present subject. The extensors of the elbow and the knee are generally in strong contraction, but altogether without tremor and with no marked relaxations or exacerbations. On taking hold of the limbs and attempting to forcibly flex the elbow or knee a very considerable degree indeed of resistance is experienced, the triceps brachii and quadriceps extensor cruris become under the stretch which the more or less effectual flexion puts upon them, still tenser than before, and on releasing the limb the joints spring back forthwith to their previous attitude of full extension. Despite, however, this powerful extensor rigidity, flexion of the elbow may be at once obtained with perfect facility by simply stimulating the toes or pad of the fore foot. When this is done the triceps enters into relaxation and the biceps passes into contraction. If, when the reflex is evolved, the condition of the triceps muscle is carefully examined, its contraction is found to undergo inhibition, and its tenseness to be broken down synchronously with and indeed very often accurately at the very moment of onset of reflex contraction in the opponent prebrachial muscles. The reaction can be initiated in more ways than one, electrical excitation of a digital nerve or mechanical excitation of the sensory root of any of the upper cervical nerves may be employed; I have seen on one occasion a rubbing of the skin of the cheek of the same side effective.

Similarly in the case of the hind limb. The extensor muscles of the knee exhibit strong steady non-tremulent contraction under the appropriate conditions of experiment. The application of hot water to the hind foot then elicits, nevertheless, an immediate flexion at knee and hip, during which not only are the flexors of those joints thrown into contraction, but the extensors of the knee joint are simultaneously *relaxed*. Electric excitation of a digital nerve or of the internal saphenous nerve anywhere along its course will also initiate the reflex.

January 28.—"On the Capacity and Residual Charge of Dielectrics as affected by Temperature and Time." By J. Hopkinson, F.R S., and E. Wilson. Received December 15, 1896.

The major portion of the experiments described in this paper have been made on window glass and ice. It is shown that for long times residual charge diminishes with rise of temperature in the case of glass, but for short times it increases both for glass and ice. The capacity of glass when measured for ordinary durations of time, such as 1/100th to 1/10th second, increases much with rise of temperature, but when measured for short periods, such as $1/10^6$ second, it does not sensibly increase. The difference is shown to be due to the residual charge which comes out between 1/50,000th second and 1/100th second. The capacity of ice when measured for periods of 1/100th to 1/10th second increases both with rise of temperature and with increase of time; its value is of the order of 80, but when measured for periods such as $1/10^6$ second, its value is less than 3. The difference again is due to residual charge coming out during short times. In the case of glass, conductivity has been observed at fairly high temperatures and after short times of electrification; it is found that the conductivity after 1/50,000th second electrification is much greater than after 1/10,000th, but for longer times is sensibly constant. Thus a continuity is shown between the conduction in dielectrics which exhibit residual charge and deviation from Maxwell's law and ordinary electrolytes.

February 4.—"On the Gases enclosed in Crystalline Rocks and Minerals." By Prof. W. A. Tilden, F.R.S.

From the time of Sir Humphry Davy it has been known that many minerals contain gases as well as liquids enclosed in cavities, which are often large enough to be visible to the unaided eye. The liquid sometimes consists of water or saline solutions, occasionally of mineral naphtha, and not unfrequently of carbon dioxide, which is recognisable by its great expansibility and total disappearance when the temperature is raised to about 31° C.

The presence of gases other than nitrogen and carbon dioxide in natural crystals had not been observed, save in one or two isolated cases, until two years ago, when helium was discovered in certain minerals by Ramsay.

In the course of experiments undertaken with the object of ascertaining, if possible, the condition in which this element, remarkable for its chemical inactivity, is contained in these minerals, I was led to the observation that granite when heated in a vacuum gives off several times its volume of gas, which is combustible, and which consists largely of hydrogen and carbonic oxide. I now find that these two gases are contained, more or less abundantly, in all the crystalline rocks, and, together with carbon dioxide and small quantities of nitrogen and marsh gas, are apparently enclosed in fine cavities which permeate the crystals of quartz, felspar, and other mineral constituents.

Of twenty different rocks examined—granite, gneiss, gabbro, schist, or basalt of different geological ages and from widely different localities—all yielded gas in which hydrogen is present, and is usually the preponderant ingredient of the mixture. The total bulk of the gases extracted, varied from a volume equal to 1·3 times the volume of the rock to 17·8 times its volume. Lava also gave gas, though in smaller quantity, and this also contained hydrogen. Graphite, quartz, beryl and tinstone, as examples of definite minerals associated with the older rocks, gave a similar result.

To account for the large proportion of hydrogen and carbonic oxide in these gases, we must suppose that the rock enclosing them was crystallised in an atmosphere rich in carbon dioxide and steam, at the same time in contact with some easily oxidisable substance, probably a metal or metallic carbide, at a moderately high temperature. No free oxygen has been found in any of these gases, neither has helium been detected. This latter substance seems to be confined to minerals which contain the heavy metals, such as uranium and thorium, and at present it has not been found in any simple silicate.

Physical Society, February 12.—Special General Meeting.—The chair was taken by Captain Abney, who, as retiring President, referred to some of the changes which had occurred in the Society during the past year. The annual subscription had been raised, but a satisfactory number of new Fellows had been enrolled. The Society had lost two by death. A good deal of work had been done in the direction suggested by the discoveries of Röntgen.—The Treasurer, Dr. Atkinson, then presented his report and balance-sheet for the year 1896. There was evidence of improvement in the financial position, but there was still a deficiency to be met. Profits from sales of publications had been small; it was desirable to reduce the price of the volumes of "Collected Papers of Joule and Wheatstone," and to call the attention of physicists to these valuable records of classical work. Mr. Walker suggested that physical laboratories, especially those in London, should be visited by Fellows of the Society, with a view to comparing notes as to the construction of apparatus; professors of colleges and other institutions should be invited to appoint visiting days for this purpose.—Votes of thanks were passed to the retiring President, Council, and Officers, and also to the Council of the Chemical Society for the use of their rooms at Burlington House.—In replying, Captain Abney said that the coming year would probably bring about further improvements in the system of abstracting and indexing, by co-operation with other Societies at home and abroad. He then read the list of Council and Officers for the year 1897–8. President, Shelford Bidwell, F.R.S.; Vice-Presidents who have filled the office of President: Dr. Gladstone, Prof. G. C. Foster, Prof. Adams, The Lord Kelvin, Prof. Clifton, Prof. Reinold, Prof. Ayrton, Prof. Fitzgerald, Prof. Rücker, Captain Abney. Vice-Presidents, Major-General E. R. Festing, L. Fletcher, Prof. Perry, G. Johnstone Stoney. Secretaries: T. H. Blakesley, H. M. Elder. Foreign Secretary (new office), Prof. S. P. Thompson. Treasurer, Dr. Atkinson. Librarian, C. Vernon Boys. Other members of Council: Walter Baily, L. Clark, A. H. Fison, Prof. Fleming, R. T. Glazebrook, Prof. A. Gray, G. Griffith, Prof. Minchin, Prof. Ramsay, J. Walker. The newly-elected President, Mr. Shelford Bidwell, then took the chair, and an ordinary meeting was held. Mr. Blakesley read a paper by Mr. H. H. Hoffert, "On the use of very small mirrors with paraffin lamp and scale." For the mirrors of reflecting instruments the author prefers small rectangular strips of microscope cover-glass, chosen thin and plane. These are first silvered and then cut to shape by a splinter of diamond embedded in wax. They are about 8 mm. long, by 1·5 mm. broad, and are suspended so that their longest sides are vertical. Rectangular mirrors suspended in this way are lighter, and have less inertia than round mirrors of equal aperture. A paraffin-lamp flame placed edgewise to the mirror gives sufficient illumination. The image of the flame is focussed on the mirror by a lens midway between them, it is a right, vertical line, and thus conforms to the shape of the mirror. A scale is fixed upon a screen between the lens and lamp; and the screen has a circular aperture just below the centre of the scale, provided with a vertical cross-wire. The relative position of screen and lens is adjusted so that an image of the wire is formed upon the scale after reflection at the mirror. Mr. Boys said he had frequently used small mirrors constructed as described by the author, and he could not see what was new in the method, except that a paraffin lamp had been found sufficiently bright for the purpose. It is desirable to diminish inertia by choosing extremely thin glass. Microscope cover-glasses are generally supplied in squares or discs very fairly equal in size; if they are dealt out on a table like a pack of cards, their relative thickness can be judged by the note produced as they fall. Flatness can be estimated nearly enough by balancing them one by one upon the knuckle nearly level with the eye, and observing the reflection of an illuminated straight edge, such as a window bar. All rejected glasses should be broken. The good ones can be further examined by a telescope and artificial star. A common "writing" diamond is best for cutting the thin plates. Special care must be taken not to distort the mirror in fixing to the suspended system. If liquid shellac is used in the attachment, distortion will certainly occur, at any rate if it is applied throughout the whole length of the mirror. The best way is to make the attachment at a mere point, near the top of the mirror; using a speck of shellac as viscous as possible, and heating, if necessary, by radiation, not by conduction. Mr. Boys thought that a reflecting prism near the mirror might be used in certain cases where a paraffin lamp with its inevitable vertical flame was required for horizontal projections. For general purposes, Mr. Boys prefers some such arrangement as the following: If the source of light is a point, a lens is employed, forming an image of the source upon the mirror. (If the source of light is a surface, this lens is evidently superfluous.) The cross-wire is stretched near to the lens on the side towards the mirror. It is now necessary to focus the cross-wire upon the scale, and this is best done by a plano-convex lens fixed as near as possible to the mirror, with its plane face towards the mirror. The light passes twice through this lens. As it may be necessary to change the plano-convex lens from time to time, according to the distance of the scale, Mr. Boys attaches it with a little vaseline to a strip of plate glass in front of the instrument. One advantage of such an optical system is that it allows the instrument to be set up in the same position, with respect to the scale, at all times. Dr. Thompson pointed out that Mr. Hoffert had obtained his results using only *one* lens, by properly choosing the position of the cross-wire.—A vote of thanks was given to the author, and the meeting adjourned until February 26.

Entomological Society, February 3.—Mr. Roland Trimen, F.R.S., President, in the chair.—Mr. F. Bates, Mr. D. D'A. Wright, and Mrs. E. Brightwen were elected Fellows of the Society.—Mr. Champion exhibited an extensive series of Coleoptera collected by Mr. R. W. Lloyd and himself in the Austrian Tyrol, and containing about 450 species, including 35 of Longicornia, and about 20 of Otiorrhynchus. He also exhibited about 85 species of Coleoptera from Cintra, Portugal, collected by Colonel Yerbury, the most interesting of these being *Carabus lusitanicus*, F.; also two specimens of the rare *Zeugophora flavicollis*, Marsh., from Colchester. Mr. Tutt showed, for Mr. W. H. B. Fletcher, typical *Zygaena ochsenheimeri*, Zell., from Piedmont, and hybrids between a female of that species and *Z. filipendulæ*. The progeny was fertile *inter se*, the males closely approaching *Z. ochsenheimeri*, the females *Z. filipendulæ* in character. He also exhibited, for Mr. J. B. Hodgkinson, a number of obscure British Microlepidoptera, some of which had been described as new species. The determinations were criticised by Lord Walsingham, Mr. Bower and Mr. Barrett, and the former speaker strongly deprecated the practice of positively recognising or describing obscure species from single or worn specimens, particularly when British.—Mr. Barrett showed specimens of the true *Platyptilia tesseradactyla*, L. (= *P. fischeri*, Zell.) new to the United Kingdom, and taken in Co. Galway.—Mr. McLachlan exhibited cooked locusts (*Schistocerca peregrina*) sold in the market of Biskra, Algeria, and received from the Rev. A. E. Eaton. They were cooked whole, but the abdomen only was eaten. The President, Mr. Barrett, and Mr. Blandford made some remarks on the subject.—A paper was communicated by Dr. A. G. Butler, on "Seasonal dimorphism in African butterflies," which led to a long discussion, chiefly on the so-called "dry-season" and "wet-season forms." Mr. Merrifield stated that he had been unable experimentally to modify the colour and markings of Lepidoptera by variations in humidity. Mr. Tutt believed that Mr. Doherty had obtained "wet season forms" of Oriental species by keeping the pupæ in a moist atmosphere.

Edinburgh.

Royal Society, February 1.—Lord Kelvin in the chair.—A paper by Dr. J. Clarence Webster, on the changes in the mucosa of the corpus uteri, and in the attached fœtal membranes during pregnancy, was laid on the table. Prof. D'Arcy Thompson described a very simple logical machine.—A paper by Lord Kelvin, Dr. Beattie and Dr. Smolan, on the conductive quality induced in air by Röntgen rays and by violet light, was read. (See page 343.)—Lord Kelvin read a paper on crystallisation according to rule. For example, as the beginning of a crystal forming from molecules moving freely in a solution consider a cluster of 13 balls, one touched by 12 neighbours around it (model shown). This presents 8 triangular beds and 6 square ones, on which a wandering molecule may lie down. Let a rule be that a wandering molecule takes the first square bed which comes in its way, but never takes a triangular bed if a square one is vacant. The 6 square beds thus become occupied, and an octahedron of 19 balls is formed, each plane face of which is an equilateral triangle of 6 balls with 3 in each edge. Each triangular face presents 4 triangular beds, of which the middle one is shallow, and the 3 around it deep (tried with a probe pin). There being now no square beds, wandering molecules take triangular beds; but the rule (to make the whole assemblage homogeneous and equilateral) must be that only deep triangular beds are eligible. Thus procedure according to rule adds 24 balls, and we have a cluster of 43 balls (model shown), which presents 2 kinds of triangular or 3-contact beds and 12 equal and similar 5-contact beds, but no square beds. The 12 5-contact beds are next to be filled. These give us a cluster of 55 balls (model shown), presenting 6 square faces of 9 balls, with 4 square beds, and 8 triangular faces of 6 balls each. The 24 square beds are next to be filled, and we have a cluster of 79 balls presenting 6 square beds. The next action, according to rule, fills these, and gives us a regular octahedron of 85 balls, with 15 balls in each face and 5 in each edge. Each triangular face contains 16 triangular beds, of which 10 are deep and 6 shallow. To continue the crystallisation, we may suppose all the deep triangular beds equally eligible; and any one of them may be taken by a molecule deposited from the solution, and any one of the 6 equal and similar 4-contact beds between it and neighbours may be taken next. We shall never find any 6-, 7-, 8-, or 9-contact beds formed if the following rule is rigorously observed in continuing the crystallisation. Five-contact beds must be occupied when any are vacant. When none of these remain, 4-contact beds must be occupied, and whenever no 5-contact or 4-contact beds remain, we shall find that we have a regular octahedron. To continue the crystallisation, any one of the deep triangular beds may be taken by a wandering molecule, and the process continued rigorously according to rule. The formation of garnet (rhombic dodekahedron) was illustrated on similar principles by cubic molecules cohering by attractions between "corners" and relatively oriented by quasi-repulsions between edges. Definite laws of force between molecules are suggested, according to which an ideal "complete" crystal of anorthic system, or of any system possessing symmetry, would be a figure of minimum potential energy, and would be of perfectly determinate figure. The number of such configurations would be infinite if the number of molecules were infinite; but practically for a crystal in nature the number that could probably occur might be hundreds, or might be only one. And *the* one configuration of absolutely least potential energy would be a perfect crystal of unique quality.

Paris.

Academy of Sciences, February 8.—M. A. Chatin in the chair.—On fictitious waterspouts, by M. H. Faye. It is contended that the name of waterspout (*trombe*) has been given to two quite distinct phenomena solely on account of their external resemblance. The true waterspout is in rapid rotation destroying whatever it touches, has a definite direction, moves with a high velocity, has no aspirating power, and comes from above. The false waterspout is distinguished by having a small and uncertain rotation, no definite course, aspirating and ascending movement, and also by the fact that its source of motion is at its base, on the earth.—New researches on the estimation of pyrophosphoric acid, by MM. Berthelot and G. André. The pyrophosphate is precipitated as the magnesium salt by a mixture of magnesium chloride, ammonium acetate and chloride, in the presence of a large excess of acetic acid. The precipitate thus obtained is of complex composition containing sodium and ammonium in addition to magnesium. The composition of the precipitate, moreover, appears to depend upon the amount of washing it has received.—Some historical remarks on metaphosphoric acid, by MM. Berthelot and G. André.—The reduction of nitrates in arable earth, by M. P. P. Dehérain. As the result of the study of the destruction of nitrates in aqueous solutions by denitrifying organisms present in manure, it is shown that the treatment of farm manure with dilute sulphuric acid, previously recommended as a means of destroying denitrifying organisms, is not only expensive, but is, moreover, useless and harmful.—Results of the solar observations made at the Royal Observatory of the Roman College during the second half of 1896, by M. P. Tacchini.—On the zeros of certain analytical functions, by M. Desaint.—On the comparison of the times of oscillation of two pendulums of very nearly the same period, by M. G. Bigourdan. A. modification of the arrangement described by M. Lippmann, in which the pendulum clock is replaced by a chronometer, and in which no electrical apparatus is required.—On a new measurement of the coefficient of viscosity of air, by MM. Ch. Fabry and A. Perot. In the absolute electrometer, described a short time ago, equilibrium was found to be only very slowly attained when the distance between the plates was very small (below 75 μ), on account of the viscosity of the air between the plates. The experimental study of the motion produced by the addition of a small surplus charge on the centre of the moving plate has led to a new determination of the coefficient of viscosity of air, $1{\cdot}73 \times 10^{-4}$ at 13° C.—Study of the variations of energy, by M. Vaschy.—On the principle of Avogadro-Ampère, considered as a limited law, by M. A. Leduc.—On the ammoniacal chlorides of silver, by M. R. Jarry. It is shown that solutions of silver chloride in ammonia contain the definite compounds $AgCl.3NH_3$ and $2AgCl.3NH_3$, and the dissociation pressure of the ammonia is the same in aqueous solution as in a vacuum.—On some colour reactions, by M. E. Pinerua. Some colour reactions obtained by the use of β-naphthol-sulphonic-acid. Tartaric, citric, malic, and nitrous acids give characteristic reactions.—On a new method of preparing primary amines, by M. Marcel Delépine. The alkyl chloride, bromide, or iodide is combined with hexamethylene amine, in presence of chloroform, and the product hydrolysed with aqueous hydrogen chloride.—Improvements in the match industry, with especial reference to the health of the operatives, by M. Magitot. The ameliorative measures proposed depend upon a good artificial ventilation, and a careful selection of the operatives, especial stress being laid on the necessity of the latter having no unsound teeth.—On the estimation of potassium bitartrate in wines, by M. Henri Gautier.—On the essence of basil, by MM. Dupont and Guerlain.—The argon and nitrogen in the blood, by MM. P. Regnard and Th. Schlœsing. The gases obtained from a litre of blood gave 20·4 cc. of argon and nitrogen, 0·42 cc. of which was argon.—On the colours of irradiation in short luminous impressions, by M. Aug. Charpentier.—On a new method of electrification, by M. Charles Henry.—Research on the evolution of the *Urnes*, by MM. J. Kunstler and A. Gruvel.—On the gum disease of the cocoa plant, by M. Louis Mangin.—On an apparatus for measuring the refractive indices of minerals in rocks, by M. Fred Wallerant.—On the granite of Pelvoux, by M. P. Termier.—Generalisation of a formula in probabilities, by M. C. Maze.

Sydney.

Royal Society of New South Wales, December 2, 1896.—Mr. J. H. Maiden, President, in the chair.—On the presence of a true manna on a "blue grass," *Andropogon annutatus*, Forsk., from Queensland, by R. T. Baker and Henry G. Smith. The substance is found on the nodes of the stems in masses as large as marbles. This appears to be the first time that a substance of this character has ever been described from a grass. Not only is the grass indigenous in Australia, but occurs in tropical Asia and Africa. The manna is sweet, and nearly three parts of it consists of the substance mannite, which, although sweet, is not a sugar. Besides the presence of this interesting substance, a peculiar ferment was discovered in the manna, which apparently has the power to decompose cane-sugar without the evolution of carbonic acid or gases of any kind. It probably belongs to the Sacchoromycetes, and is allied to the ferments of which the yeast plant is a type. It has been isolated from the manna, and was shown at the Society working in a solution of cane-sugar, and also under the microscope. The investigations are not yet completed; but, so far, it appears to be probably the cause of the occurrence of the mannite in the manna, and not only has it the power to alter cane-sugar to mannite, but, with the assistance of yeast, to decompose mannite also—a fact of no little interest.—Remarkable hailstorm of November 17, 1896, in parts of parish of Gordon, by E. du Faur—On the determination of the meridian line by solar observations with any altazimuth instrument, by G. H. Knibbs. The paper dealt with the rigorous mathematical theory of the subject; tables and formulæ, for facilitating the reducing of this class of observations with precision, were supplied. The astronomical conditions of good results were fully dealt with, the matter being of considerable importance in practical geodesy.